

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
DC voltage sources: single values	Solid state voltage standard, standard cell	Direct comparison	0	1.018	V	Fixed voltage	0 V, 1 V, 1.018 V	50	nV	2	95%	No			MIKES	1a
DC voltage sources: single values	Solid state voltage standard	Direct comparison	10	10	V			200	nV	2	95%	No			MIKES	2a
DC voltage sources: single values	Solid state voltage standard, standard cell	Direct comparison with standard	1	10	V	Fixed voltage	1 V, 1.018 V, 10 V	0.2	µV/V	2	95%	Yes			MIKES	3
DC voltage sources: low values	Multifunction calibrator	Comparison with reference standard	100	100	mV			2.5	µV/V	2	95%	Yes			MIKES	7
DC voltage sources: low values	Multifunction calibrator	Comparison with reference standard	1	10	V	Fixed voltage	1 V, 10 V	0.7 to 0.5	µV/V	2	95%	Yes			MIKES	8
DC voltage sources: low values	Multifunction calibrator	Direct comparison with standard	0	10	mV			100	nV	2	95%	No			MIKES	12a
DC voltage sources: low values	Multifunction calibrator: voltage, $U$	Direct comparison with standard	0	10	V			(0.3 + 2 $U$ ), $U$ in V, values range from 0.3 to 20.3	µV	2	95%	No			MIKES	13
DC voltage sources: intermediate values	Multifunction calibrator: voltage, $U$	Direct comparison with standard	10	100	V			(10 + 6 $U$ ), $U$ in V, values range from 70 to 610	µV	2	95%	No			MIKES	16
DC voltage sources: intermediate values	Multifunction calibrator	Direct comparison with standard	100	1000	V			10	µV/V	2	95%	Yes			MIKES	17
DC voltage sources: intermediate values	Multifunction calibrator	Comparison with reference standard	100	1000	V	Fixed voltage	100 V, 1000 V	2 to 3	µV/V	2	95%	Yes			MIKES	10

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DC voltage meters: very low values	Nanovoltmeter	Comparison with reference standard	0	1	mV			100	nV	2	95%	No			MIKES	12b
DC voltage meters: intermediate values	DC voltmeter, multimeter	Direct comparison	0	1	V			50	nV	2	95%	No			MIKES	1c
DC voltage meters: intermediate values	DC voltmeter, multimeter	Direct comparison	1	10	V			50 to 200	nV	2	95%	No			MIKES	2b
DC voltage meters: intermediate values	DC voltmeter	Direct comparison with standard	1	10	V	Fixed voltage	1 V, 10 V	1	µV/V	2	95%	Yes			MIKES	18
DC voltage meters: intermediate values	DC voltmeter	Comparison with reference standard	0.1	0.1	V			3	µV/V	2	95%	Yes			MIKES	20
DC voltage meters: intermediate values	DC voltmeter	Comparison with reference standard	100	100	V			2	µV/V	2	95%	Yes			MIKES	21
DC voltage meters: intermediate values	DC voltmeter	Comparison with reference standard	1000	1000	V			5	µV/V	2	95%	Yes			MIKES	22
DC voltage meters: intermediate values	DC voltmeter: voltage, $U$	Direct comparison with standard	0	10	V			(0.3 + 2U), $U$ in V, values range from 0.3 to 20.3	µV	2	95%	No			MIKES	23
DC voltage meters: intermediate values	DC voltmeter: voltage, $U$	Direct comparison with standard	10	100	V			(10 + 6U), $U$ in V, values range from 70 to 610	µV	2	95%	No			MIKES	26

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DC voltage meters: intermediate values	DC voltmeter	Direct comparison with standard	100	1000	V			10	µV/V	2	95%	Yes			MIKES	27
DC voltage ratios: up to 1100 V	Resistive divider: ratio, $k$	Direct comparison with standard	0.1	0.1		Input voltage	1 V to 100 V	(0.4E-06 + $U_0/U_{out})k$ , $U_0 = 50$ nV, $U_{out}$ output voltage, values from 9E-08 to 4E-08		2	95%	No			MIKES	28
DC voltage ratios: up to 1100 V	Resistive divider: ratio, $k$	Direct comparison with standard	0.01	0.01		Input voltage	1 V to 1000 V	(1E-06 + $U_0/U_{out})k$ , $U_0 = 50$ nV, $U_{out}$ output voltage, values from 6E-08 to 1E-08		2	95%	No			MIKES	29
DC resistance standards and sources: low values	Standard resistor	DCC bridge and range extender	0.1	1	mΩ	Current	1 A to 100 A	10	µΩ/Ω	2	95%	Yes			MIKES	32b
DC resistance standards and sources: low values	Standard resistor	DCC bridge and range extender	1	10	mΩ	Current	1 A to 100 A	5	µΩ/Ω	2	95%	Yes			MIKES	32c
DC resistance standards and sources: low values	Standard resistor	DCC bridge and range extender	10	100	mΩ	Power	10 mW	2	µΩ/Ω	2	95%	Yes			MIKES	32d

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DC resistance standards and sources: low values	Standard resistor	CCC bridge	0.01	0.01	Ω	Current	50 mA to 100 mA	1	μΩ/Ω	2	95%	Yes			MIKES	34
DC resistance standards and sources: low values	Standard resistor	DCC bridge	0.1	1	Ω	Power	10 mW	0.8	μΩ/Ω	2	95%	Yes			MIKES	35
DC resistance standards and sources: intermediate values	Standard resistor	Comparison with QHR standard by CCC bridge	100	100	Ω	Power	2.5 mW	0.01	μΩ/Ω	2	95%	Yes			MIKES	30
DC resistance standards and sources: intermediate values	Standard resistor	CCC bridge	1	10000	Ω	Voltage	0.1 V to 1 V	0.05	μΩ/Ω	2	95%	Yes			MIKES	31
DC resistance standards and sources: intermediate values	Standard resistor	DCC bridge	1	100000	Ω	Power	10 mW	0.4	μΩ/Ω	2	95%	Yes			MIKES	36
DC resistance standards and sources: intermediate values	Standard resistor	DCC bridge	0.1	1	MΩ	Voltage	30 V	2	μΩ/Ω	2	95%	Yes			MIKES	36b
DC resistance standards and sources: high values	Standard resistor	DCC bridge	1	100	MΩ	Voltage	30 V to 1 kV	3 to 5	μΩ/Ω	2	95%	Yes			MIKES	37
DC resistance standards and sources: high values	Standard resistor	DCC bridge	0.1	1	GΩ	Voltage	100 V to 1 kV	20	μΩ/Ω	2	95%	Yes			MIKES	38
DC resistance standards and sources: high values	Standard resistor	Teraohmmeter	1	10	GΩ			0.2	mΩ/Ω	2	95%	Yes			MIKES	39b

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DC resistance standards and sources: high values	Standard resistor	Teraohmmeter	10	100	GΩ			0.5	mΩ/Ω	2	95%	Yes			MIKES	39c
DC resistance standards and sources: high values	Standard resistor	Teraohmmeter	0.1	1	TΩ			2	mΩ/Ω	2	95%	Yes			MIKES	39d
DC resistance standards and sources: high values	Standard resistor	Teraohmmeter	1	10	TΩ			3	mΩ/Ω	2	95%	Yes			MIKES	39e
DC resistance standards and sources: high values	Standard resistor	Teraohmmeter	10	100	TΩ			5	mΩ/Ω	2	95%	Yes			MIKES	39f
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	1	100	Ω			10	μΩ/Ω	2	95%	Yes			MIKES	40
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	100	10000	Ω			5	μΩ/Ω	2	95%	Yes			MIKES	41
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	10	100	kΩ			10	μΩ/Ω	2	95%	Yes			MIKES	42
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	0.1	1	MΩ			25	μΩ/Ω	2	95%	Yes			MIKES	43
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	1	10	MΩ			50	μΩ/Ω	2	95%	Yes			MIKES	44
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	10	100	MΩ			300	μΩ/Ω	2	95%	Yes			MIKES	45

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DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	0	10	Ω			0.2	mΩ	2	95%	No			MIKES	46
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	10	10000	Ω			10	μΩ/Ω	2	95%	Yes			MIKES	47
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	10	100	kΩ			20	μΩ/Ω	2	95%	Yes			MIKES	49
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	0.1	1	MΩ			30	μΩ/Ω	2	95%	Yes			MIKES	50
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	1	10	MΩ			100	μΩ/Ω	2	95%	Yes			MIKES	51
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Direct comparison with standard	10	100	MΩ			500	μΩ/Ω	2	95%	Yes			MIKES	52
DC resistance meters: low values	Multimeter	Direct comparison with standard	1	1	Ω			200	μΩ	2	95%	No			MIKES	53b
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	10	Ω			200	μΩ	2	95%	No			MIKES	53c
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	100	100	Ω			200	μΩ	2	95%	No			MIKES	54b
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	1	1	kΩ			2	mΩ	2	95%	No			MIKES	54c

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DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	10	kΩ			20	mΩ	2	95%	No			MIKES	54d
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	100	100	kΩ			500	mΩ	2	95%	No			MIKES	55b
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	1	1	MΩ			10	Ω	2	95%	No			MIKES	56
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	10	MΩ			300	Ω	2	95%	No			MIKES	57
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	100	100	MΩ			30	kΩ	2	95%	No			MIKES	58
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	1	1	GΩ			3	MΩ	2	95%	No			MIKES	59
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	100	Ω			10	μΩ/Ω	2	95%	Yes			MIKES	61
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	0.1	10	kΩ			10	μΩ/Ω	2	95%	Yes			MIKES	62
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	100	kΩ			20	μΩ/Ω	2	95%	Yes			MIKES	63
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	0.1	1	MΩ			50	μΩ/Ω	2	95%	Yes			MIKES	64

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DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	1	10	MΩ			100	μΩ/Ω	2	95%	Yes			MIKES	65
DC resistance meters: intermediate values	Multimeter	Direct comparison with standard	10	100	MΩ			500	μΩ/Ω	2	95%	Yes			MIKES	66
DC current sources: low values	Multifunction calibrator	Voltage across resistance standard	0	0.1	mA			0.5	nA	2	95%	No			MIKES	67a
DC current sources: low values	Multifunction calibrator	Direct comparison with standard	10	100	μA			3	nA	2	95%	No			MIKES	71a
DC current sources: intermediate values	Multifunction calibrator	Voltage across resistance standard	0.1	100	mA			5	μA/A	2	95%	Yes			MIKES	68a
DC current sources: intermediate values	Multifunction calibrator	Voltage across resistance standard	0.1	2	A			5 to 10	μA/A	2	95%	Yes			MIKES	69a
DC current sources: intermediate values	Multifunction calibrator	Voltage across resistance standard	2	20	A			10 to 20	μA/A	2	95%	Yes			MIKES	70a
DC current sources: intermediate values	Multifunction calibrator	Direct comparison with standard	0.1	1000	mA			10	μA/A	2	95%	Yes			MIKES	71c
DC current sources: transconductance ratio	Transconductance amplifier		1	1	S	Amplifier output current	2 A to 20 A	100	μS/S	2	95%	Yes			MIKES	79
DC current meters: low values	Multimeter	Voltage across resistance standard	0	100	nA			50	pA	2	95%	No			MIKES	67c
DC current meters: low values	Multimeter	Voltage across resistance standard	0.1	1	μA			100	pA	2	95%	No			MIKES	67d

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DC current meters: low values	Multimeter	Voltage across resistance standard	1	10	µA			400	pA	2	95%	No			MIKES	67e
DC current meters: low values	Multimeter	Voltage across resistance standard	10	100	µA			3	nA	2	95%	No			MIKES	67f
DC current meters: intermediate values	Multimeter	Voltage across resistance standard	0.1	100	mA			5	µA/A	2	95%	Yes			MIKES	68b
DC current meters: intermediate values	Multimeter	Voltage across resistance standard	0.1	2	A			5 to 10	µA/A	2	95%	Yes			MIKES	69b
DC current meters: intermediate values	Multimeter	Voltage across resistance standard	2	20	A			10 to 20	µA/A	2	95%	Yes			MIKES	70b
DC current meters: intermediate values	Multimeter	Direct comparison with standard	0.1	1000	mA			10	µA/A	2	95%	Yes			MIKES	74c
DC current meters: high values	Current clamp	Multiturn coil	10	100	A			0.5	%	2	95%	Yes			MIKES	77
DC current ratios	DC current comparator: ratio, k	Comparison with standard resistors	1	10		Current	5 mA to 100 mA	3E-08 k		2	95%	No			MIKES	78
AC resistance: modulus	Standard resistor	Direct comparison with standard by digital sampling method	0.001	1	Ω	Frequency	45 Hz to 65 Hz	40 to 20	µΩ/Ω	2	95%	Yes		This CMC is related to the next one	MIKES	80a
AC resistance: argument	Standard resistor	Direct comparison with standard by digital sampling method	-0.1	0.1	rad	Resistance	1 mΩ to 1 Ω	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	81a

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AC resistance: modulus	Standard resistor	Direct comparison with standard by digital sampling method	1	1000	Ω	Frequency	45 Hz to 65 Hz	20	μΩ/Ω	2	95%	Yes		This CMC is related to the next one	MIKES	82
AC resistance: argument	Standard resistor	Direct comparison with standard by digital sampling method	-0.1	0.1	rad	Resistance	1 Ω to 1 kΩ	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	83
Capacitance: low loss capacitors	Standard capacitor	AH2500 bridge	10	10	pF	Frequency	1 kHz	5	μF/F	2	95%	Yes			MIKES	84
Capacitance: low loss capacitors	Standard capacitor	AH2500 bridge	100	100	pF	Frequency	1 kHz	5	μF/F	2	95%	Yes			MIKES	85
Capacitance: low loss capacitors	Standard capacitor	AH2500 bridge	1000	1000	pF	Frequency	1 kHz	10	μF/F	2	95%	Yes			MIKES	86
Capacitance: low loss capacitors	Standard capacitor	AH2500 bridge	10	10	nF	Frequency	1 kHz	30	μF/F	2	95%	Yes			MIKES	86b
Capacitance: low loss capacitors	Standard capacitor	AH2500 bridge	100	100	nF	Frequency	1 kHz	100	μF/F	2	95%	Yes			MIKES	86c
Capacitance: dielectric capacitors	Fixed capacitor: capacitance, C	AH2500 bridge	0	10	pF	Frequency	1 kHz	Q[5E-06, 1E-05C], C in pF, values range from 5E-06 to 1E-04	pF	2	95%	No			MIKES	87
Capacitance: dielectric capacitors	Fixed capacitor	AH2500 bridge	10	100	pF	Frequency	1 kHz	10	μF/F	2	95%	Yes			MIKES	88
Capacitance: dielectric capacitors	Fixed capacitor	AH2500 bridge	100	1000	pF	Frequency	1 kHz	10	μF/F	2	95%	Yes			MIKES	89
Capacitance: dielectric capacitors	Fixed capacitor	AH2500 bridge	1	10	nF	Frequency	1 kHz	30	μF/F	2	95%	Yes			MIKES	90

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Capacitance: dielectric capacitors	Fixed capacitor	AH2500 bridge	10	100	nF	Frequency	1 kHz	200	µF/F	2	95%	Yes			MIKES	91
Capacitance: dielectric capacitors	Fixed capacitor	AH2500 bridge	100	1000	nF	Frequency	1 kHz	400	µF/F	2	95%	Yes			MIKES	92
AC voltage: AC-DC transfer difference at low voltages	Thermal converter, resistive divider	Direct comparison	2	500	mV	Frequency	10 Hz to 1 MHz	5 to 1200	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix</a>		MIKES	94b
AC voltage: AC-DC transfer difference at low voltages	AC-DC transfer standard	Direct comparison	2	500	mV	Frequency	10 Hz to 1 MHz	20 to 1200	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix_2</a>		MIKES	141b
AC voltage: AC-DC transfer difference at low voltages	AC-DC transfer standard	Comparison to AC DC meter	0.1	0.5	V	Frequency	20 Hz to 1 MHz	35 to 450	µV/V	2	95%	Yes	<a href="#">AC-DC METER</a>		MIKES	142b
AC voltage: AC-DC transfer difference at low voltages	Multifunction calibrator	ACV meter	0.1	0.5	V	Frequency	20 Hz to 50 kHz	35 to 75	µV/V	2	95%	Yes	<a href="#">CALIBRATOR AC-DC</a>		MIKES	135b
AC voltage: AC-DC transfer difference at medium voltages	Thermal converter	Direct comparison	0.5	5	V	Frequency	10 Hz to 1 MHz	5 to 50	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix</a>		MIKES	94c
AC voltage: AC-DC transfer difference at medium voltages	AC-DC transfer standard	Direct comparison	0.5	5	V	Frequency	10 Hz to 1 MHz	20 to 250	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix_2</a>		MIKES	141c
AC voltage: AC-DC transfer difference at medium voltages	AC-DC transfer standard	Comparison to AC DC meter	0.5	5	V	Frequency	20 Hz to 1 MHz	17 to 400	µV/V	2	95%	Yes	<a href="#">AC-DC METER</a>		MIKES	142c
AC voltage: AC-DC transfer difference at medium voltages	Multifunction calibrator	ACV meter	0.5	5	V	Frequency	20 Hz to 50 kHz	20 to 70	µV/V	2	95%	Yes	<a href="#">CALIBRATOR AC-DC</a>		MIKES	135c

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AC voltage: AC-DC transfer difference at higher voltages	Thermal converter, range resistor	Direct comparison	5	1000	V	Frequency	10 Hz to 1 MHz	5 to 100	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix</a>		MIKES	94d
AC voltage: AC-DC transfer difference at higher voltages	AC-DC transfer standard	Direct comparison	5	1000	V	Frequency	10 Hz to 1 MHz	15 to 300	µV/V	2	95%	Yes	<a href="#">ACDC_U_matrix_2</a>		MIKES	141d
AC voltage: AC-DC transfer difference at higher voltages	AC-DC transfer standard	Comparison to AC-DC meter	5	1000	V	Frequency	20 Hz to 1 MHz	19 to 400	µV/V	2	95%	Yes	<a href="#">AC-DC METER</a>		MIKES	142d
AC voltage: AC-DC transfer difference at higher voltages	Multifunction calibrator	ACV meter	5	1000	V	Frequency	20 Hz to 50 kHz	20 to 60	µV/V	2	95%	Yes	<a href="#">CALIBRATOR AC-DC</a>		MIKES	135d
AC voltage up to 1000 V: sources	Multifunction calibrator	Direct comparison with DC sampling	0.01	600	V	Frequency	45 Hz to 1 kHz	50	µV/V	2	95%	Yes			MIKES	121
AC voltage up to 1000 V: sources	Multifunction calibrator	ACV meter	0.002	1000	V	Frequency	20 Hz to 1 MHz	25 to 4600	µV/V	2	95%	Yes	<a href="#">CALIBRATOR ACV RMS</a>		MIKES	123b
AC voltage up to 1000 V: meters	Multimeter	Comparison to calibrator	0.002	1000	V	Frequency	20 Hz to 1 MHz	60 to 14000	µV/V	2	95%	Yes	<a href="#">DMM ACV RMS</a>		MIKES	147b
AC voltage ratio: modulus	Voltage divider: ratio, $k$	Direct comparison	0.00005	0.1		Input voltage	10 V to 1000 V	(5E-04 + $U_0/U_{out}$ ) $k$ , $U_0 = 1 \mu\text{V}$ , $U_{out}$ output voltage		2	95%	No		This CMC is related to the next one	MIKES	155
						Frequency	45 Hz to 65 Hz									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
AC voltage ratio: argument	Voltage divider	Direct comparison	-1.57	1.57	rad	Voltage ratio	5E-05 to 0.1	1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	156
						Input voltage	10 V to 1000 V									
						Frequency	45 Hz to 65 Hz									
AC current: AC-DC transfer difference	Multifunction calibrator, amplifier	AC meter plus thermocouple shunt resistors	0.01	20	A	Frequency	40 Hz to 10 kHz	45 to 250	µA/A	2	95%	Yes	<a href="#">AC-DC CURRENT</a>		MIKES	163b
AC current up to 100 A: sources	Multifunction calibrator, amplifier	Direct comparison	0.01	20	A	Frequency	40 Hz to 10 kHz	50 to 260	µA/A	2	95%	Yes	<a href="#">AC RMS CURRENT MFC</a>		MIKES	174c
AC current up to 100 A: sources	Multifunction calibrator	Direct comparison	0.025	10	A	Frequency	45 Hz to 65 Hz	50	µA/A	2	95%	Yes			MIKES	179a
AC current up to 100 A: sources	Multifunction calibrator	Direct comparison	0.01	1	A	Frequency	40 Hz to 10 kHz	0.2 to 2	mA/A	2	95%	Yes	<a href="#">AC CURRENT MFC DMM</a>		MIKES	168b
AC current up to 100 A: sources: transconductance	Transconductance amplifier	AC/DC standard resistor	1	1	S	Output current	2 A to 20 A	180	µS/S	2	95%	Yes			MIKES	173
						Frequency	40 Hz to 1 kHz									
AC current up to 100 A: meters	Multimeter	Direct comparison	0.01	20	A	Frequency	40 Hz to 10 kHz	75 to 300	µA/A	2	95%	Yes	<a href="#">AC RMS CURRENT DMM</a>		MIKES	174d
AC current up to 100 A: meters	Multimeter	Direct comparison	0.025	10	A	Frequency	45 Hz to 65 Hz	50	µA/A	2	95%	Yes			MIKES	179b
AC current up to 100 A: meters: amplitude	Rogowski coil, current transducer	Comparison with standard	5	10	A	Frequency	45 Hz to 65 Hz	100	µA/A	2	95%	Yes		This CMC is related to the next one	MIKES	185
AC current up to 100 A: meters: phase	Rogowski coil, current transducer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	186
						Current	5 A to 10 A									

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
AC current up to 100 A: meters: amplitude	Rogowski coil, current transducer	Comparison with standard	10	100	A	Frequency	45 Hz to 65 Hz	200	µA/A	2	95%	Yes		This CMC is related to the next one	MIKES	187
AC current up to 100 A: meters: phase	Rogowski coil, current transducer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	188
						Current	10 A to 100 A									
AC current ratio up to 100 A: modulus	Current transformer	Comparison with standard	2E-03	20		Frequency	45 Hz to 65 Hz	1E-04		2	95%	Yes		This CMC is related to the next one	MIKES	185b
						Input current	1 A to 10 A									
						Output current	20 mA to 20 A									
AC current ratio up to 100 A: argument	Current transformer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	186b
						Input current	1 A to 10 A									
						Output current	20 mA to 20 A									
AC current ratio up to 100 A: modulus	Current transformer	Comparison with standard	2E-04	2		Frequency	45 Hz to 65 Hz	2E-04		2	95%	Yes		This CMC is related to the next one	MIKES	187b
						Input current	10 A to 100 A									
						Output current	20 mA to 20 A									
AC current ratio up to 100 A: argument	Current transformer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	188b
						Input current	10 A to 100 A									
						Output current	20 mA to 20 A									
AC power and energy: single phase ( $f \leq 400$ Hz), active power	Power meter or converter	Comparison with standard	0	5000	W	Voltage	30 V to 500 V	75	µW/VA	2	95%	Yes			MIKES	189
						Current	0.02 A to 10 A									
						Power factor	1 to 0, inductive or capacitive									

## Electricity and Magnetism, Finland, MIKES (Mittatekniikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
						Frequency	45 Hz to 65 Hz									
AC power and energy: single phase ( $f \leq 400$ Hz), reactive power	Power meter	Comparison with standard	0	600	Var	Voltage	60 V to 120 V	150	μvar/VA	2	95%	Yes			MIKES	190
						Current	1 A to 5 A									
						Power factor	1 to 0, inductive or capacitive									
						Frequency	45 Hz to 65 Hz									
High DC voltage: high voltage sources	DC kilovolt source	Dedicated set-up for high voltage measurement	1	50	kV			50	μV/V	2	95%	Yes			HUT	1
High DC voltage: high voltage sources	DC kilovolt source	Dedicated set-up for high voltage measurement	50	100	kV			100	μV/V	2	95%	Yes			HUT	40
High DC voltage: high voltage sources	DC kilovolt source	Dedicated set-up for high voltage measurement	100	200	kV			500	μV/V	2	95%	Yes			HUT	2
High DC voltage: high voltage meters	DC kilovoltmeter, dedicated set-up for high voltage	Comparison with dedicated set-up for high voltage	1	50	kV			50	μV/V	2	95%	Yes			HUT	3
High DC voltage: high voltage meters	DC kilovoltmeter, dedicated set-up for high voltage	Comparison with dedicated set-up for high voltage	50	100	kV			100	μV/V	2	95%	Yes			HUT	41
High DC voltage: high voltage meters	DC kilovoltmeter, dedicated set-up for high voltage	Comparison with dedicated set-up for high voltage	100	200	kV			500	μV/V	2	95%	Yes			HUT	4
High DC voltage: ratios	High voltage resistive divider, DC high voltage probe	Comparison with reference divider	1E-06	1		Input voltage	1 kV to 50 kV	50E-06		2	95%	Yes			HUT	5
						Output voltage	100 mV to 1000 V									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
High DC voltage: ratios	High voltage resistive divider, DC high voltage probe	Comparison with reference divider	1E-06	1		Input voltage	50 kV to 100 kV	100E-06		2	95%	Yes			HUT	42
						Output voltage	100 mV to 1000 V									
High DC voltage: ratios	High voltage resistive divider, DC high voltage probe	Comparison with reference divider	1E-06	1		Input voltage	100 kV to 200 kV	500E-06		2	95%	Yes			HUT	6
						Output voltage	100 mV to 1000 V									
High voltage impedance: capacitance	Fixed compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0.1	1	nF	Capacitance	0.1 nF, 1 nF	20	μF/F	2	95%	Yes			HUT	7
						Frequency	45 Hz to 60 Hz									
						Voltage	< 200 kV									
						Current	> 30 μA									
High voltage impedance: capacitance	Fixed compressed gas capacitor, capacitor for high voltage	Current comparator bridge	10	10	nF	Voltage	< 30 kV	50	μF/F	2	95%	Yes			HUT	8
						Frequency	45 Hz to 60 Hz									
						Current	> 30 μA									
High voltage impedance: capacitance	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0.01	100	nF	Voltage	< 200 kV	100	μF/F	2	95%	Yes			HUT	9
						Frequency	45 Hz to 60 Hz									
						Current	30 μA to 1 A									
High voltage impedance: capacitance	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0.1	100	μF	Voltage	< 10 kV	500	μF/F	2	95%	Yes			HUT	10
						Frequency	45 Hz to 60 Hz									
						Current	30 μA to 1 A									
High voltage impedance: capacitance	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0.1	100	μF	Voltage	< 1 kV	500	μF/F	2	95%	Yes			HUT	10a
						Frequency	45 Hz to 60 Hz									
						Current	> 30 μA									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0	1E-03		Capacitance	10 pF to 1 µF	1E-05		2	95%	No			HUT	11
						Frequency	45 Hz to 60 Hz									
						Voltage	< 200 kV									
						Current	30 µA to 1 A									
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	1E-03	2		Capacitance	10 pF to 1 µF	1	%	2	95%	Yes			HUT	43
						Frequency	45 Hz to 60 Hz									
						Voltage	< 200 kV									
						Current	30 µA to 1 A									
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0	1E-03		Capacitance	1 µF to 10 µF	2E-05		2	95%	No			HUT	44
						Frequency	45 Hz to 60 Hz									
						Voltage	< 1 kV									
						Current	> 30 µA									
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	1E-03	2		Capacitance	1 µF to 10 µF	2	%	2	95%	Yes			HUT	45
						Frequency	45 Hz to 60 Hz									
						Voltage	< 1 kV									
						Current	> 30 µA									
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0	1E-03		Capacitance	10 µF to 100 µF	3E-05		2	95%	No			HUT	46
						Frequency	45 Hz to 60 Hz									
						Voltage	< 1 kV									
						Current	> 30 µA									
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	1E-03	2		Capacitance	10 µF to 100 µF	3	%	2	95%	Yes			HUT	47
						Frequency	45 Hz to 60 Hz									
						Voltage	< 1 kV									
						Current	> 30 µA									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
High voltage impedance: inductance	High voltage reactor: loss angle	Simultaneous sampling of current and voltage	1E-06	10	H	Frequency	45 Hz to 60 Hz	0.3	mH/H	2	95%	Yes		This CMC is related to the next one	HUT	12
						Current	50 mA to 300 A									
						Voltage	10 mV to 1000 V									
High voltage impedance: inductance loss angle	High voltage reactor	Simultaneous sampling of current and voltage	0	350	mrad	Frequency	45 Hz to 60 Hz	0.2	mrad	2	95%	No		This CMC is related to the previous one	HUT	13
						Current	50 mA to 300 A									
						Voltage	10 mV to 1000 V									
High voltage impedance: burden: modulus	Instrument transformer burden: absolute value of impedance	Simultaneous sampling of current and voltage	0.1	30000	Ω	Frequency	45 Hz to 60 Hz	1	mΩ/Ω	2	95%	Yes		This CMC is related to the next one	HUT	60
						Voltage	< 300 V									
						Current	10 mA to 15 A									
High voltage impedance: burden: argument	Instrument transformer burden: phase angle	Simultaneous sampling of current and voltage	0	π/2	rad	Frequency	45 Hz to 60 Hz	2	mrad	2	95%	No		This CMC is related to the previous one	HUT	61
						Voltage	< 300 V									
						Current	10 mA to 15 A									
AC high voltage: meters	AC high voltage meter, dedicated set-up for high voltage measurements: rms value	Comparison with dedicated set-up for high voltage	1	200	kV	Frequency	45 Hz to 60 Hz	100	μV/V	2	95%	Yes		This CMC is related to the next one	HUT	15
AC high voltage: peak values	AC high voltage meter, dedicated set-up for high voltage measurements	Comparison with dedicated set-up for high voltage	1	200	kV	Frequency	45 Hz to 60 Hz	100	μV/V	2	95%	Yes		This CMC is related to the previous one	HUT	16

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
AC high voltage ratio: ratio error	High voltage transformer, high voltage divider	Current comparator bridge	0	3	%	Frequency	45 Hz to 60 Hz	0.01	%	2	95%	No			HUT	17
						Input voltage	1 kV to 200 kV									
						Output voltage	20 V to 1000 V									
AC high voltage ratio: phase displacement	High voltage transformer, high voltage divider	Current comparator bridge	0	2	mrad	Frequency	45 Hz to 60 Hz	0.02	mrad	2	95%	No			HUT	18
						Input voltage	1 kV to 200 kV									
						Output voltage	20 V to 1000 V									
AC high voltage ratio: phase displacement	High voltage transformer, high voltage divider	Current comparator bridge	2	100	mrad	Frequency	45 Hz to 60 Hz	10	mrad/rad	2	95%	Yes			HUT	18b
						Input voltage	1 kV to 200 kV									
						Output voltage	20 V to 1000 V									
AC high voltage ratio: ratio error	High voltage transformer, high voltage divider	Simultaneous sampling of input and output voltages	0	3	%	Frequency	45 Hz to 60 Hz	0.01	%	2	95%	No			HUT	17a
						Input voltage	1 kV to 200 kV									
						Output voltage	0.1 V to 20 V									
AC high voltage ratio: phase displacement	High voltage transformer, high voltage divider	Simultaneous sampling of input and output voltages	0	100	mrad	Frequency	45 Hz to 60 Hz	0.02	mrad	2	95%	No			HUT	18a
						Input voltage	1 kV to 200 kV									
						Output voltage	0.1 V to 20 V									
Pulsed high voltage and current: lightning impulse voltage parameters	Digital recorder, peak voltmeter, impulse calibrator, EMC surge generator: peak value	Impulse voltage calibrator	0.05	300	V	Impulse shape	according to IEC60060-1	1	mV/V	2	95%	Yes			HUT	19
Pulsed high voltage and current: lightning impulse voltage parameters	Digital recorder, peak voltmeter, impulse calibrator, EMC surge generator: peak value	Impulse voltage calibrator	0.3	1	kV	Impulse shape	according to IEC60060-1	1.5	mV/V	2	95%	Yes			HUT	20

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
Pulsed high voltage and current: lightning impulse voltage parameters	Lightning impulse voltage measurement set-up, EMC surge generator: peak value	Comparison with dedicated set-up for high voltage	1	600	kV	Impulse shape	according to IEC60060-1	5	mV/V	2	95%	Yes			HUT	21
Pulsed high voltage and current: lightning impulse time parameters	Digital recorder, impulse calibrator, EMC surge generator: front time	Impulse voltage calibrator	0.84	1.56	μs	Impulse shape	according to IEC60060-1	10	ms/s	2	95%	Yes			HUT	22
					Voltage	0.05 V to 300 V										
Pulsed high voltage and current: lightning impulse time parameters	Digital recorder, impulse calibrator, EMC surge generator: front time	Impulse voltage calibrator	0.84	1.56	μs	Impulse shape	according to IEC60060-1	15	ms/s	2	95%	Yes			HUT	23
					Voltage	300 V to 1000 V										
Pulsed high voltage and current: lightning impulse time parameters	Lightning impulse voltage measurement set-up, EMC surge generator: front time	Comparison with dedicated set-up for high voltage	0.84	1.56	μs	Impulse shape	according to IEC60060-1	20	ms/s	2	95%	Yes			HUT	24
					Voltage	1 kV to 600 kV										
Pulsed high voltage and current: lightning impulse time parameters	Digital recorder, impulse calibrator, EMC surge generator: time to half value	Impulse voltage calibrator	40	60	μs	Impulse shape	according to IEC60060-1	5	ms/s	2	95%	Yes			HUT	25
					Voltage	0.05 V to 300 V										
Pulsed high voltage and current: lightning impulse time parameters	Digital recorder, impulse calibrator, EMC surge generator: time to half value	Impulse voltage calibrator	40	60	μs	Impulse shape	according to IEC60060-1	5	ms/s	2	95%	Yes			HUT	26
					Voltage	300 V to 1000 V										

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
Pulsed high voltage and current: lightning impulse time parameters	Lightning impulse voltage measurement set-up, EMC surge generator: time to half value	Comparison with dedicated set-up for high voltage	40	60	μs	Impulse shape	according to IEC60060-1	10	ms/s	2	95%	Yes		HUT	27	
					Voltage	1 kV to 600 kV										
Pulsed high voltage and current: switching impulse voltage parameters	Digital recorder, peak voltmeter, impulse calibrator: peak value	Impulse voltage calibrator	0.05	300	V	Impulse shape	according to IEC60060-1	1	mV/V	2	95%	Yes		HUT	28	
Pulsed high voltage and current: switching impulse voltage parameters	Digital recorder, peak voltmeter, impulse calibrator: peak value	Impulse voltage calibrator	0.3	1	kV	Impulse shape	according to IEC60060-1	1	mV/V	2	95%	Yes		HUT	29	
Pulsed high voltage and current: switching impulse voltage parameters	Lightning impulse voltage measurement set-up: peak value	Comparison with dedicated set-up for high voltage	1	200	kV	Impulse shape	according to IEC60060-1	2	mV/V	2	95%	Yes		HUT	30	
Pulsed high voltage and current: switching impulse time parameters	Digital recorder, impulse calibrator: time to peak	Impulse voltage calibrator	20	300	μs	Impulse shape	according to IEC60060-1	30	ms/s	2	95%	Yes		HUT	31	
					Voltage	0.05 V to 300 V										
Pulsed high voltage and current: switching impulse time parameters	Digital recorder, impulse calibrator: time to peak	Impulse voltage calibrator	20	300	μs	Impulse shape	according to IEC60060-1	30	ms/s	2	95%	Yes		HUT	32	
					Voltage	300 V to 1000 V										

## Electricity and Magnetism, Finland, MIKES (Mittateknikan Keskus, Centre for Metrology and Accreditation), HUT (Helsinki University of Technology)



Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
Pulsed high voltage and current: switching impulse time parameters	Lightning impulse voltage measurement set-up: time to peak	Comparison with dedicated set-up for high voltage	20	300	μs	Impulse shape	according to IEC60060-1	30	ms/s	2	95%	Yes			HUT	33
						Voltage	1 kV to 200 kV									
Pulsed high voltage and current: switching impulse time parameters	Digital recorder, impulse calibrator: time to half value	Impulse voltage calibrator	2000	4000	μs	Impulse shape	according to IEC60060-1	5	ms/s	2	95%	Yes			HUT	34
						Voltage	0.05 V to 300 V									
Pulsed high voltage and current: switching impulse time parameters	Digital recorder, impulse calibrator: time to half value	Impulse voltage calibrator	2000	4000	μs	Impulse shape	according to IEC60060-1	5	ms/s	2	95%	Yes			HUT	35
						Voltage	300 V to 1000 V									
Pulsed high voltage and current: switching impulse time parameters	Lightning impulse voltage measurement set-up: time to half value	Comparison with dedicated set-up for high voltage	2000	4000	μs	Impulse shape	according to IEC60060-1	10	ms/s	2	95%	Yes			HUT	36
						Voltage	1 kV to 200 kV									
Pulsed high voltage and current: impulse current parameters	Dedicated measurement set-up, current shunt peak value	Comparison with dedicated set-up for high voltage	1	10000	A	Impulse shape	according to IEC60060-1	30	mA/A	2	95%	Yes		This CMC is related to the next one	HUT	37
Pulsed high voltage and current: impulse current time parameters	Dedicated measurement set-up, current shunt	Comparison with dedicated set-up for high voltage	1	100	μs	Impulse shape	according to IEC60060-1	50	ms/s	2	95%	Yes		This CMC is related to the previous one	HUT	50
Electric discharge: apparent charge	Partial discharge calibrator or meter: apparent charge $q$	Comparison with partial discharge calibrator	1	10	pC			0.2	pC	2	95%	No			HUT	39

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
Electric discharge: apparent charge	Partial discharge calibrator or meter: apparent charge $q$	Comparison with partial discharge calibrator	10	1000	pC			20	mC/C	2	95%	Yes			HUT	51
Electric discharge: response: amplitude value	ESD generator	Comparison with dedicated set-up for ESD	1	50	A	Impulse shape	according to 61000 4-2	50	mA/A	2	95%	Yes		This CMC is related to the next one	HUT	52
Electric discharge: response: time parameters	ESD generator	Comparison with dedicated set-up for ESD	0.7	2	ns	Impulse shape	according to 61000 4-2	50	ms/s	2	95%	Yes		This CMC is related to the previous one	HUT	53
					Current	1 A to 50 A										
High AC current: sources	High current AC source	Comparison with dedicated set-up for high AC current	0.2	1.5	kA	Frequency	45 Hz to 60 Hz	300	μA/A	2	95%	Yes			HUT	54
High AC current: meters	Current transducer	Comparison with dedicated set-up for high AC current	0.2	1.5	kA	Frequency	45 Hz to 60 Hz	300	μA/A	2	95%	Yes			HUT	55
High AC current: meters	Current transducer	Comparison with dedicated set-up for high AC current	1.5	3	kA	Frequency	45 Hz to 60 Hz	600	μA/A	2	95%	Yes			HUT	56
High AC current: meters: amplitude	Rogowski coil, current transducer	Comparison with standard	100	2000	A	Frequency	45 Hz to 65 Hz	200	μA/A	2	95%	Yes		This CMC is related to the next one	MIKES	187c
High AC current meters: phase	Rogowski coil, current transducer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	188c
					Current	100 A to 2000 A										

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
High AC current: ratio error	Current transformer	Comparison with standard	1E-05	0.2		Frequency	45 Hz to 65 Hz	200E-06		2	95%	No		Uncertainty is given for the current ratio This CMC is related to the next one	MIKES	187d
						Input current	100 A to 2 kA									
						Output current	20 mA to 20 A									
High AC current ratio: phase displacement	Current transformer	Comparison with standard	0	3.14	rad	Frequency	45 Hz to 65 Hz	0.1	mrad	2	95%	No		This CMC is related to the previous one	MIKES	188d
						Input current	100 A to 2 kA									
						Output current	20 mA to 20 A									
High AC current: ratio error	Current transformer, current transducer	Comparison with dedicated set-up for high AC current	0	5	%	Frequency	45 Hz to 60 Hz	0.03	%	2	95%	No		HUT	57	
						Input current	0.2 kA to 1.5 kA									
						Output current	10 mA to 20 A									
High AC current: ratio error	Current transformer, current transducer	Comparison with dedicated set-up for high AC current	0	5	%	Frequency	45 Hz to 60 Hz	0.05	%	2	95%	No		HUT	58	
						Input current	1.5 kA to 3.0 kA									
						Output current	10 mA to 20 A									
High AC current ratio: phase displacement	Current transducer, current transformer	Comparison with dedicated set-up for high AC current	0	100	mrad	Frequency	45 Hz to 60 Hz	0.2	mrad	2	95%	No		HUT	59	
						Input current	0.2 kA to 1.5 kA									
						Output current	10 mA to 20 A									
High AC current ratio: phase displacement	Current transducer, current transformer	Comparison with dedicated set-up for high AC current	0	100	mrad	Frequency	45 Hz to 60 Hz	0.4	mrad	2	95%	No		HUT	59a	
						Input current	1.5 kA to 3.0 kA									
						Output current	10 mA to 20 A									

**Uncertainty table: ACDC\_U\_matrix**

AC voltage: AC-DC transfer difference at low voltages, MIKES Internal Identifier: 94b

AC voltage: AC-DC transfer difference at medium voltages, MIKES Internal Identifier: 94.c

AC voltage: AC-DC transfer difference at higher voltages, MIKES Internal Identifier: 94.d

	<b>10 Hz</b>	<b>20 Hz</b>	<b>30 Hz to 300 Hz</b>	<b>400 Hz to 10 kHz</b>	<b>20 kHz to 30 kHz</b>	<b>50 kHz</b>	<b>70 kHz</b>	<b>100 kHz</b>	<b>200 kHz</b>	<b>300 kHz</b>	<b>500 kHz</b>	<b>700 kHz to 800 kHz</b>	<b>1 MHz</b>
<b>2 mV to 20 mV</b>	400	400	400	400	400	400	400	400	500	500	500	800	1200
<b>20 mV to 200 mV</b>	100	100	80	80	80	80	80	80	150	150	150	200	300
<b>0.2 V to 0.5 V</b>	10	5	5	5	5	6	7	7	15	15	20	40	50
<b>0.5 V to 5 V</b>	10	5	5	5	5	6	7	7	15	15	20	40	50
<b>5 V to 10 V</b>	10	5	5	5	5	6	7	7	15	15	20	40	50
<b>10 V to 30 V</b>	20	6	6	6	6	7	8	8	15	15	20	40	50
<b>30 V to 100 V</b>	30	6	6	6	6	8	10	15	20	-	-	-	-
<b>100 V to 300 V</b>	30	7	7	7	7	10	15	20	-	-	-	-	-
<b>300 V to 1000 V</b>	-	-	10	10	15	25	50	100	-	-	-	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

**Uncertainty table: ACDC\_U\_matrix\_2**

AC voltage: AC-DC transfer difference at low voltages, MIKES Internal Identifier: 141b

AC voltage: AC-DC transfer difference at medium voltages, MIKES Internal Identifier: 141c

AC voltage: AC-DC transfer difference at higher voltages, MIKES Internal Identifier: 141d

	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
<b>2 mV to 20 mV</b>	400	400	400	400	400	400	400	400	500	500	500	800	1200
<b>20 mV to 200 mV</b>	100	100	80	80	80	80	80	80	150	150	150	200	300
<b>0.2 V to 0.5 V</b>	50	40	30	20	20	30	30	40	70	90	100	160	250
<b>0.5 V to 5 V</b>	50	40	30	20	20	30	30	40	70	90	100	160	250
<b>5 V to 10 V</b>	50	30	20	15	15	20	25	30	50	60	80	130	220
<b>10 V to 30 V</b>	50	30	20	20	20	20	25	30	50	60	80	130	220
<b>30 V to 100 V</b>	50	30	20	20	20	20	25	30	50	-	-	-	-
<b>100 V to 300 V</b>	60	40	30	30	40	60	60	100	-	-	-	-	-
<b>300 V to 1000 V</b>	-	-	40	50	80	150	200	300	-	-	-	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

**Uncertainty table: AC-DC METER**

AC voltage: AC-DC transfer difference at low voltages, MIKES Internal Identifier: 142b

AC voltage: AC-DC transfer difference at medium voltages, MIKES Internal Identifier: 142c

AC voltage: AC-DC transfer difference at higher voltages, MIKES Internal Identifier: 142d

	<b>20 Hz</b>	<b>40 Hz</b>	<b>53 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>20 kHz</b>	<b>50 kHz</b>	<b>100 kHz</b>	<b>500 kHz</b>	<b>1 MHz</b>
<b>100 mV</b>	75	45	-	40	40	40	60	90	150	450
<b>500 mV</b>	70	40	-	35	35	35	55	80	140	400
<b>1 V</b>	50	20	-	17	17	17	35	60	110	400
<b>5 V</b>	50	20	-	19	19	19	35	60	110	400
<b>10 V</b>	50	20	-	19	19	19	35	60	110	400
<b>100 V</b>	55	30	-	25	25	25	60	100	-	-
<b>1000 V</b>	-	-	40	40	40	-	-	-	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

**Uncertainty table: CALIBRATOR AC-DC**

AC voltage: AC-DC transfer difference at low voltages, MIKES Internal Identifier: 135b

AC voltage: AC-DC transfer difference at medium voltages, MIKES Internal Identifier: 135c

AC voltage: AC-DC transfer difference at higher voltages, MIKES Internal Identifier: 135d

	<b>20 Hz</b>	<b>40 Hz</b>	<b>53 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>20 kHz</b>	<b>50 kHz</b>
<b>100 mV</b>	75	45	-	40	40	40	60
<b>500 mV</b>	70	40	-	35	35	35	60
<b>1 V</b>	55	20	-	20	20	20	35
<b>5 V</b>	55	25	-	20	20	20	40
<b>10 V</b>	55	25	-	20	20	20	40
<b>100 V</b>	55	30	-	30	30	30	60
<b>1000 V</b>	-	-	45	45	45	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

**Uncertainty table: CALIBRATOR ACV RMS**

AC voltage up to 1000V: sources, MIKES Internal Identifier: 123b

	<b>20 Hz</b>	<b>40 Hz</b>	<b>53 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>20 kHz</b>	<b>50 kHz</b>	<b>100 kHz</b>	<b>500 kHz</b>	<b>1 MHz</b>
<b>2 mV</b>	1200	970	-	970	970	970	970	2300	3900	4600
<b>20 mV</b>	200	150	-	150	150	150	230	350	830	1350
<b>100 mV</b>	95	65	-	55	55	55	80	150	350	800
<b>200 mV</b>	85	55	-	50	50	50	70	130	310	750
<b>1 V</b>	55	30	-	25	25	25	40	60	200	650
<b>10 V</b>	55	30	-	30	30	30	40	65	300	810
<b>100 V</b>	60	35	-	35	40	65	100	-	-	-
<b>1000 V</b>	-	50	50	50	-	-	-	-	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

**Uncertainty table: DMM ACV RMS**

AC voltage up to 1000V: meters, MIKES Internal Identifier: 147b

	<b>20 Hz</b>	<b>40 Hz</b>	<b>53 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>20 kHz</b>	<b>50 kHz</b>	<b>100 kHz</b>	<b>500 kHz</b>	<b>1 MHz</b>
<b>2 mV</b>	2300	2100	-	2100	2100	2100	2100	4200	12000	14000
<b>20 mV</b>	400	320	-	320	320	320	510	910	2300	3400
<b>100 mV</b>	250	150	-	150	150	150	300	760	1400	3000
<b>200 mV</b>	200	120	-	110	110	110	260	650	1300	2600
<b>1 V</b>	140	60	-	60	60	60	110	230	1100	1600
<b>10 V</b>	140	65	-	60	60	60	110	200	1200	2600
<b>100 V</b>	140	70	-	70	70	70	190	440	-	-
<b>1000 V</b>	-	-	75	75	75	-	-	-	-	-

The expanded uncertainties given in this table are expressed in  $\mu\text{V/V}$

### **Uncertainty table: AC-DC CURRENT**

AC current: AC-DC transfer difference, MIKES Internal Identifier: 163b

	<b>40 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>10 kHz</b>
<b>10 mA</b>	45	45	45	45
<b>100 mA</b>	45	45	45	45
<b>1 A</b>	55	55	55	55
<b>10 A</b>	100	100	100	200
<b>20 A</b>	100	100	100	250

The expanded uncertainties given in this table are expressed in  $\mu\text{A}/\text{A}$

### **Uncertainty table: AC RMS CURRENT MFC**

AC current up to 100 A: sources, MIKES Internal Identifier: 174c

	<b>40 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>10 kHz</b>
<b>10 mA</b>	50	50	50	50
<b>100 mA</b>	50	50	50	60
<b>1 A</b>	60	60	60	110
<b>10 A</b>	110	110	110	210
<b>20 A</b>	110	110	110	260

The expanded uncertainties given in this table are expressed in  $\mu\text{A}/\text{A}$

**Uncertainty table: AC CURRENT MFC DMM**

AC current up to 100 A: sources, MIKES Internal Identifier: 168b

	40 Hz	400 Hz	1 kHz	5 kHz	10 kHz
10 mA	200	200	200	200	500
100 mA	200	200	200	200	500
1 A	1000	1000	1000	1000	2000

The expanded uncertainties given in this table are expressed in  $\mu\text{A}/\text{A}$

**Uncertainty table: AC RMS CURRENT DMM**

AC current up to 100 A: meters, MIKES Internal Identifier: 174d

	<b>40 Hz</b>	<b>400 Hz</b>	<b>1 kHz</b>	<b>10 kHz</b>
<b>10 mA</b>	80	80	80	80
<b>100 mA</b>	80	80	80	85
<b>1 A</b>	75	75	75	120
<b>10 A</b>	120	120	120	250
<b>20 A</b>	150	150	150	300

The expanded uncertainties given in this table are expressed in  $\mu\text{A}/\text{A}$